

## CLAIMS

What is claimed is:

- 1    1.    A method for evaluating a plurality of moving queries over moving objects, the  
2        queries and objects moving with respect to each other, the method comprising:  
3        constructing a bounding box to contain each one of the plurality of moving  
4        objects and moving queries;  
5        creating an object index for each one of the plurality of moving objects and a  
6        query index for each one of the moving queries using the corresponding bounding  
7        box; and  
8        evaluating the plurality of queries periodically using the query index to determine  
9        which moving objects to include in each moving query evaluation.
- 1    2.    The method of claim 1, wherein the step of constructing the bounding box  
2        comprises varying the size and shape of each bounding box based upon a speed  
3        and a direction of motion of the corresponding moving object or moving query.
- 1    3.    The method of claim 1, wherein the step of constructing the bounding box  
2        comprises placing the moving object or the moving query within the  
3        corresponding bounding box in an initial position arranged to maximize the  
4        length of time that each moving object and moving query is disposed within the  
5        bounding box.
- 1    4.    The method of claim 1, wherein the step of constructing the bounding box  
2        comprises constructing a rectangle for each moving object and moving query,  
3        sizing the rectangle based upon a speed and a direction of motion of the  
4        corresponding moving object or moving query, and placing the moving object or

5 moving query at a corner of the rectangle such that the direction of motion is  
6 generally aligned with a diagonal of the rectangle.

1 5. The method of claim 1, further comprising receiving at least one of location  
2 information and motion information for each one of the moving objects and  
3 moving queries, determining which moving objects and moving queries have  
4 invalidated the corresponding bounding box based upon the received  
5 information, and replacing invalidated bounding boxes with new bounding boxes.

1 6. The method of claim 1, wherein the step of evaluating the moving queries  
2 periodically comprises generating predictive query results.

1 7. The method of claim 6, wherein the step of generating predictive query results  
2 comprises creating a motion function for each moving query and each moving  
3 object based upon a present location and a velocity vector associated with each  
4 moving object and moving query, computing a predicted path for each moving  
5 object and moving query based upon the associated motion function, comparing  
6 the predicted paths to actual paths for the moving objects and queries and  
7 computing new motion functions only when the predicted paths vary from the  
8 actual paths by a pre-determined threshold value.

1 8. The method of claim 6, wherein the step of generating predictive query results  
2 comprises using the bounding boxes to determine which moving objects to  
3 consider when generating the predictive query results.

1 9. The method of claim 8, further comprising selecting moving objects for the  
2 predictive query that have bounding boxes intersecting with a bounding box  
3 associated with the query.

- 1 10. The method of claim 1, wherein the step of periodically evaluating the moving  
2 queries comprises maintaining a moving object table containing information  
3 about the moving objects.
- 1 11. The method of claim 10, wherein the step of evaluating the moving queries  
2 further comprises scanning the moving object table and updating the moving  
3 object index and the moving query index.
- 1 12. The method of claim 1, wherein the step of periodically evaluating the moving  
2 queries comprises maintaining a moving query table containing information  
3 about the moving queries.
- 1 13. The method of claim 12, wherein the step of evaluating the moving queries  
2 further comprises scanning the moving query table and updating the moving  
3 object index and the moving query index.
- 1 14. A computer readable medium containing a computer executable code that when  
2 read by a computer causes the computer to perform a method of evaluating a  
3 plurality of moving queries over moving objects, the method comprising:  
4 constructing a bounding box to contain each one of the plurality of moving  
5 objects and moving queries;  
6 creating an object index for each one of the plurality of moving objects and a  
7 query index for each one of the moving queries using the corresponding bounding  
8 box; and  
9 evaluating the plurality of queries periodically using the query index.
- 1 15. The computer readable medium of claim 14, wherein the step of constructing the  
2 bounding box comprises varying the size and shape of each bounding box based

3       upon a speed and a direction of motion of the corresponding moving object or  
4       moving query.

1   16.   The computer readable medium of claim 14, wherein the step of constructing the  
2       bounding box comprises placing the moving object or moving query within the  
3       corresponding bounding box in an initial position arranged to maximize the  
4       length of time that each moving object and moving query is disposed within the  
5       bonding box.

1   17.   The computer readable medium of claim 14, wherein the step of constructing the  
2       bounding box comprises constructing a rectangle for each moving object and  
3       moving query, sizing the rectangle based upon a speed and a direction of motion  
4       of the corresponding moving object or moving query, and placing the moving  
5       object or moving query at a corner of the rectangle such that the direction of  
6       motion is generally aligned with a diagonal of the rectangle.

1   18.   The computer readable medium of claim 14, wherein the method further  
2       comprises receiving at least one of location information and motion information  
3       for each one of the moving objects and moving queries, determining which  
4       moving objects and moving queries have invalidated the corresponding bounding  
5       box based upon the received information, and replacing invalidated bounding  
6       boxes with new bounding boxes.

1   19.   The computer readable medium of claim 14, wherein the step of evaluating the  
2       moving queries periodically comprises generating predictive query results.

1   20.   The computer readable medium of claim 19, wherein the step of generating  
2       predictive query results comprises creating a motion function for each moving  
3       query and each moving object based upon a present location and a velocity vector

4 associated with each moving object and moving query, computing a predicted  
5 path for each moving object and moving query based upon the associated motion  
6 function, comparing the predicted paths to actual paths for the moving objects  
7 and queries and computing new motion functions only for moving objects and  
8 moving queries whose predicted paths vary from their actual paths by a pre-  
9 determined threshold value.

1 21. The computer readable medium of claim 19, wherein the step of generating  
2 predictive query results comprises using the bounding boxes to determine which  
3 moving objects to consider when generating the predictive query results.

1 22. The computer readable medium of claim 21, wherein the method further  
2 comprises selecting moving objects for the predictive query that have bounding  
3 boxes intersecting with a bounding box associated with the query.

1 23. The computer readable medium of claim 14, wherein the step of periodically  
2 evaluating the moving queries comprises maintaining a moving object table  
3 containing information about the moving objects.

1 24. The computer readable medium of claim 23, wherein the step of evaluating the  
2 moving queries further comprises scanning the moving object table and updating  
3 the moving object index and the moving query index.

1 25. The computer readable medium of claim 14, wherein the step of periodically  
2 evaluating the moving queries comprises maintaining a moving query table  
3 containing information about the moving queries.

1 26. The computer readable medium of claim 25, wherein the step of evaluating the  
2 moving queries further comprises scanning the moving query table and updating  
3 the moving object index and the moving query index.

1 27. A system for evaluating a plurality of moving queries over a plurality of moving  
2 objects, the system comprising:  
3 a plurality of moving objects;  
4 a plurality of moving queries, each query associated with a spatial range;  
5 a plurality of motion-adaptive bounding boxes, each bounding box associated  
6 with one of the moving objects or moving queries;  
7 at least one monitoring system capable of monitoring the location and motion of  
8 the moving objects and moving queries and of evaluating the moving queries, the  
9 monitoring system comprising a motion-adaptive query index and a motion-  
10 adaptive object index.

1 28. The system of claim 27, wherein the motion-adaptive bounding boxes are  
2 adaptive to both the speed and frequency of changes in direction of the associated  
3 moving object or moving query.

1 29. The system of claim 27, wherein each moving query comprises a spatial range  
2 and the spatial range is contained within the motion-adaptive bounding box  
3 associated with the moving query.

1 30. The system of claim 27, wherein the monitoring system further comprising a  
2 moving object table and a moving query table containing information about the  
3 moving objects and queries.

1 31. The system of claim 30, wherein the monitoring system further comprises a logic  
2 control unit for evaluating the moving queries, a receiver in communication with

- 3 the logic control unit for receiving information about the moving objects and
- 4 queries and a storage system in communication with the logic control unit for
- 5 storing the indexes and tables.